
NACD engineering

Dependencies

A Network ACD system requires that all nodes in the system have the same configuration. Networking parameters for ISDN and ESN *must be* consistent throughout all nodes or switches in the system with respect to NACD. Significant feature interactions may result unless all switches have the appropriate feature packages and classes of service enabled for NACD.

For the proper supporting generic and release, consult your Northern Telecom representative.

MSDL Engineering Guidelines

When configurations include a tandem Meridian 1, ensure that the D-channel link speeds are engineered to meet required response and performance objectives. Please refer to the MSDL Engineering Guidelines in the *Meridian 1 Capacity Engineering* 553-3001-149.

Package dependencies

NACD requires X11 Release 15 or later issues of software. Expanded Target capabilities are introduced with the Enhanced Overflow (EOVF) package (178), which is also a prerequisite for the Network ACD package (207).

The following are the minimum package requirements for Network ACD:

Package name	Mnemonic	Package number
Basic Routing	BRTE	14
Digit Display	DDSP	19
Basic Queuing	BQUE	28
Network Class Of Service	NCOS	32
Basic ACD	BACD	40
ACD Package B	ACDB	41
Network Alternate Route Selection	NARS	58
Coordinated Dial Pan	CDP	59
PBX Interface for DTI/CPI	PBXI	75
ISDN Signaling	ISDN	145
ISDN Primary Rate Access (CLID)	PRA	146
ISDN Signaling Link	ISL	147
Advanced Network service — Tandem nodes	NTWK	148
Enhanced Overflow (ACD)	EOVF	178
Network ACD	NACD	207

Note: Please remember that an error code is output for every package requirement not supported on your machine. For a complete definition of all error codes and system messages refer to the *X11 input/output guide*. Also, a list of the available feature packages and package requirements is included in *X11 features and services*.

Feature limitations

Calls from trunks without Disconnect Supervision are not able to initiate Call Requests.

Automatic Trunk Maintenance (ATM) is not supported on ISDN PRA or ISL trunks.

Network CPND is only supported on Meridian 1 nodes within the network.

Tandem Tie Trunk Networks (TTTNs) are not supported by NACD.

Only one location per NACD node can be used with HLOC in LD 15.

Pretranslation is not supported on Target IDs in the Routing Tables.

Calls ineligible for NACD treatment are:

- ACD Ring Again calls
- Call Park Recall calls
- a call active in Teleset Messaging

There should be one home location code per node.

There can be no more than 20 Call Requests pending for any one call.

Feature requirements

Private Network Identifier (PNI) A Private Network Identifier (PNI) relates to the customer number. It is required for interworking between switches. Within one network, use the same PNI value in both the Customer Data Block (LD 15) and the Route Data Block (LD 16). When operating between different networks, the Customer Data Block PNI is the PNI for your switch and the Route Data Block PNI is the PNI for the remote switch where the route terminates.

ESN requirements

The Electronic Switched Network (ESN) provides least cost routing between locations in a private network with a consistent dialing plan. Consistent dialing plans for each node in the network are provided by the Coordinated Dialing Plan (CDP) or the Uniform Dialing Plan (UDP). If MAX is equipped, a 7-digit dialing plan is required. For a complete description, refer to “Electronic Switched Networks (ESN)” on page 60.

Each NACD node within the network must have a unique address that is known throughout the network. NACD requires that all nodes within the network have *either* a Coordinated Dialing Plan (CDP) *or* a Uniform Dialing Plan (UDP). The system with NACD cannot have *both* CDP and UDP.

These dialing plans are needed to identify each node within the network. All nodes within the network must be able to recognize every other node in the network. Identification is provided by the Local Steering Code (LSC) for CDP or the Home Location Code (HLOC) for UDP. When signaling messages are sent between nodes, each node is identified along with the return route for that node in response.

The Source identifier is put in the Source ACD DN field of the AUX messages at the Target node, and shown on the agent's Digit Display on call presentation.

Coordinated Dialing Plan (CDP) A Coordinated Dialing Plan (CDP) consists of the CDP code and the Directory Number (DN). This dialing plan does not need an access code because the CDP code is part of the internal dialing plan.

The CDP code is one of the following:

- Distant Steering Code (DSC)
- Local Steering Code (LSC)

The complete CDP can be from 3 to 7 digits long, or 3 to 10 digits with the DN Expansion package (DNXP, Package 150) enabled for Distant and Local Steering Codes. The DN length is defined in the ESN service change LD 86 at the NCDP prompt.

The Target ACD DN identifier is the remote ACD DN defined in the Routing Table, and can only use the Distant Steering Code (DSC).

Source ACD DN identifiers are composed of the Local Steering Code (LSC) followed by the Source ACD DN. Every node in the network must recognize the LSC used for Source identifiers as a Distant Steering Code (DSC). Trunk Steering Codes (TSCs) are not supported by ISDN; and therefore, are not supported by NACD.

Define 7-Digit CDP If no CDP is defined or if the existing CDP is 7 digits long, then the CDP can be used for the NACD application.

Overlay 86 ESN data block must have the number of digits in the CDP (NCDP) code prompt equal 7. Overlay 87 defines the 3-digit LSC. The LSC must have a PMI that deletes 3. A 3-digit DSC is required for each node on the network. Overlay 15, Customer Data Block, must also define LSC as the already defined LSC from Overlay 87. This programming must be done at all the nodes in the network.

Note: In Overlay 86, when defining Route List Entries that are associated with either DSCs or LOCs used with the NACD applications:

- The routes (ROUT) must be only ISDN routes. Also, the ISDN routes cannot step to non-ISDN routes.
- The PNI defined for the routes must be equal to the PNI defined in Overlay 15, Customer Data Block, of the node that it is directly connected to.
- No digit manipulation (DMI) can be defined; in other words, DMI = 0.

Uniform Dialing Plan (UDP) The Uniform Dialing Plan has an access code, a UDP code, and a DN. If the Network Alternate Route Selection (NARS, package 58) is enabled, there are two access codes that can be used, AC1 or AC2, and the location code. With the Basic Alternate Route Selection (BARS, package 57), you can only use AC1. Access codes for either AC1 or AC2 can be 1 or 2 digits long. The UDP must be 7 digits without the AC.

The UDP code can be any one of the following:

- Location Code (LOC)
- Home Location Code (HLOC)

If the Target node has a 5- to 7-digit ACD DN defined, only the last 4 digits are used as an identifier. When the terminating telephone answers the call, only the last 4 digits are shown as the CLID. The CLID can be used as a call back number.

Source ACD DN identifications are built from the Home Location Code (HLOC) and the Source ACD DN. The HLOC must be included in the AC1 translation table. Every node on the network must define the location code used for Target DN's as part of the AC1 translation table. Target identifiers are defined in the routing tables.

Recommendations

Customer configurations

Network ACD can function in three basic configurations: similar service, special service, and a hybrid of the two. There can exist a combination of these NACD configurations within the same network.

Similar Service Network This configuration is used when there is only one service handled by NACD, and all ACD agents are equally capable of handling any incoming call.

Every ACD DN within the network must be defined in all the other ACD DN's Routing Tables. Only the Oldest Call in Network (OCN) option is enabled, and all incoming trunks should be defined with the same priority.

OCN = YES

HPQ = NO

Special service network Here, there may be different services being offered by agents throughout the network. Each agent is specially trained for a particular product or service, but is still able to answer any incoming call. The ACD user can define specialized services among groups of agents and still allow calls to be evenly dispersed among all available agents during peak traffic times.

Only the ACD DN with similar functions should be defined as Targets for each other. Every ACD DN should have OCN disabled (NO) and HPQ enabled (YES). All incoming trunks should be defined as High-Priority trunks.

OCN = NO

HPQ = YES

Hybrid network A hybrid network is a union of the two configurations mentioned above. Different services or products are being offered, but they are closely related. A TOF call for one ACD DN should have precedence over other calls overflowing to the same ACD DN. Still, it is best to answer the oldest calls first. After answering all TOF calls, agents return to answering calls in their own High-Priority queue.

Every ACD DN within the network must have all the other ACD DN defined in the Routing Tables. Then, both OCN and HPQ are disabled (OFF).

OCN = NO

HPQ = NO

NACD engineering guidelines

When independent Automatic Call Distribution (ACD) nodes are properly networked using the Network Automatic Call Distribution (NACD) package, the overall performance of the network can improve in three areas:

- reducing Average Speed of Answer (ASA)
- increasing total ACD calls handled by the network
- reducing ACD agents required to maintain the same service level

NACD is designed to allow the call distribution centers to function as one virtual queue based on the length of time calls have waited for available agents and on the work loads at each location.

Note: Do not forward calls to centers that are overloaded or understaffed. Use care when provisioning trunks between locations. Underprovisioning can result in agents being reserved for calls, but with no facility available for presenting the overflowed network call.

It is necessary to look at the call registers and the real-time effect of adding NACD to new or existing Meridian switches.

The following are guidelines for establishing NACD, including:

- Target table definition
- parameter definition
- network requirements
- design of the NACD Routing Table
- incremental impact engineering

Target table definition

NACD automatically routes calls to available agents. For maximum efficiency, define the order of remote Targets in the NACD Routing Table according to the guidelines below.

Real-time impact

CPU real-time engineering is always required at the Source node. The CPU of a tandem or remote Target node needs engineering only when its busy hours coincide with those of the Source node.

Noncoincidence busy hour (time zone difference)

Busy hours in branch offices are often similar for large organizations spread over a wide geographical area. NACD improves the utilization of facilities by overflowing calls arriving at the Source node to Target nodes in a different time zone so that idle resources at Target nodes with different busy hours can be fully utilized. This allows for a better balance of agents across the network. It may also reduce the need to provide extra staff at the Source location during peak times as the traffic is now distributed across the network.

Table 3
NACD Target entry registration

Reasons to get NACD002	Actions
Dialing Plan is incorrect	1. Try making a B-channel call from Source to Target node dialing the number that is in the target table. Make another call from Target node using the HLOC value in OVL 15 of the Source node and the Source ACD-DN preceded by Access code defined in OVL 15 at Target node. 2. If okay, then enable D-channel messages and try again. Look at originating and terminating IEs in facility messages. 3. If not okay, check DB.
D-channel is down	Enable D-channel at all affected nodes.
Route list does not have ISDN trunk	Define ISDN routes in route list.

ACD DN load at each node (spare capacity)

The relative ACD DN load between the Source node and a Target node is one of the most important considerations in determining where to overflow the waiting call. If the average loading per ACD DN is known, then the ACD DN with the lowest loading receives the highest priority for receiving networked overflow calls.

To calculate the ACD DN with the lowest loading (or the highest spare capacity), use the following formula:

$$S = (33 - A) \times N$$

where:

S = spare capacity

A = agents load in CCS (Calls Accepted $\times$ Avg. Work Sec.) / 100

N = number of agents in the queue

Once the network is installed, it may be necessary to recalculate the spare capacity to provide better balance on the network.

The spare capacity is calculated only for the Target location since it receives the extra traffic.

If S is negative, the Target ACD DN is overloaded and cannot accept any overflow traffic.

Agent group size in an ACD DN

Due to the higher traffic carrying capacity of a larger service group, when two ACD DN's have the same average agent loading per ACD DN, the ACD DN with the most agents receives a higher priority in the routing table.

Number of hops

In general, a call with a number of switches involved in the call set-up requires more resources than a network call involving only two switches. As a general rule, the ACD DN's co-located in the Source node receive the highest priority in the routing table.

The next consideration is for locations with only one hop or point-to-point connections. If possible, nodes requiring tandem connections should receive a lower priority depending on how many tandem points are involved.

Note: The real-time impact of each NACD call is 56 ms at the Source location, while tandem calls require 215 ms of real time. Each NACD call requires 194 ms to set up, while a nonnetwork ACD call requires 138 ms. Each time a Call Request is sent over the network, one call register is required at the Source node and one call register is required at the Target nodes. These call registers are required in addition to those necessary to establish the call. They are required only with Call Request messaging for NACD calls.

Parameter definition

The parameters used to control NACD are defined in the following sections.

Flow Control (Overlay 23: FCTH)

The Flow Control option opens and closes the ACD DN for network calls. Once the number of Call Requests received over the network meets the call request queue size defined in Overlay 23, the queue is shut down (INACTIVE) for network calls. For the queue to open for network calls, the pending queue request size must drop to a value equal to the flow calls control.

For example, a call request queue size of 50 with a flow control of 10 allows the queue to become inactive after 50 call requests are pending. After 10 calls or 10 Call Requests have been answered or removed, leaving 40 remaining in queue, the queue will reopen.

Call Request Queue Size (Overlay 23: CRQS)

It is recommended that the Call Request Queue Size be approximately 20% higher than the number of trunks available for networking. If the customer selects the Oldest Call in Network option (OCN), set this value at 5% over trunking capacity. This avoids reserving agents for calls on the network when trunking facilities are unavailable. Flow Control (FCTH) is typically set at 25% of the call request queue size.

The CRQS must be defined for each ACD DN in the network.

Resend Timer (Overlay 23: RSND)

This is the length of time the Source node waits for a response from the Target node after sending a Call Request message. When the Resend Timer expires, another message is sent. If the second Call Request message expires without a response, the Call Request is removed from the network queue. The Resend Timer is set to a 4-second default and should be changed only if the network uses multiple hops and ISL with lower baud rates.

A single hop typically requires 100 ms of real time to set up the call. When the Resend Timer is too large, the control function of the timer to limit traffic to busy nodes is lost. If the Resend Timer is too small, the access of calls to nodes may be limited unnecessarily.

The Resend Timer must be defined for the Source node and the Target nodes.

Reserve Agent Timer (Overlay 23: RAGT)

The Reserve Agent Timer indicates the maximum amount of time an agent is reserved for a network call. The range is 2–30 seconds with the default set at 16 seconds. The Reserve Agent Timer can be changed using 2-second increments.

If the Reserve Agent Timer is set too high, the agent is reserved waiting for calls. If the Reserve Agent Timer is set too low, the agent may be freed before the network facility can set up the call. Different timer settings can be tried through Load Management. Subsequent calls are presented to agents only after the Reserve Agent Timer has expired.

The RAGT must be defined only for Target queues.

Oldest Call in Network (Overlay 23: OCN)

This feature determines if the oldest call in the network is answered ahead of calls to the Source location. Use caution with this feature. Because agents are reserved for network calls, agents may remain idle while calls wait in the local queue.

To avoid reserving all the agents for network calls, split the ACD group into two areas: one area for all calls and the second area for a group of agents equal to the number of tie lines between the network locations. This solution allows local calls to overflow by time into the area for all calls.

The OCN option must be defined only for Target queues.

ACD agents requirement at each node

The current method of calculating ACD agents inflates ACD calls by 30% to allow for peak traffic during busy hours. The provisioning of agents requires 30% spare capacity to cover traffic peaks. When NACD is applied normally, this 30% spare capacity is not necessary since queued calls are offered to other nodes in the network after the designation overflow timer expires. However, if all nodes peak at the same busy hour, the 30% spare capacity is still required.

Trunking requirements at the Source and Target nodes

Each node on the network must have a connection to the Source node, either directly or through one or more tandem nodes. It is assumed that the trunking requirements have been satisfied to handle existing traffic. For NACD, estimate the incremental requirement for carrying overflow calls to each Target node.

In the current engineering procedure, there is an adjustment similar to agent traffic on the trunking requirement for traffic peaking of 30%. Waiting calls are eventually handled by other nodes with less average waiting and do not occupy the trunks.

Keep the peak load adjustment, but reduce the Average Speed of Answer (ASA) by half in the trunk calculation to allow for the potential reduction in waiting time. Modify trunk traffic calculations to the Source node by multiplying Average Busy Season Busy Hour (ABSBH) traffic by 1.3 to account for trunk traffic peak load. If the level of given traffic in calls already reflects the peaking factor, then replace 1.3 with 1.0 in the following calculation.

$$\text{Trunk Traffic} = (\text{Offered Calls} \times 1.3 \times \text{DCP}/100) + (\text{Offered Calls} \times 1.3 \times 0.5 \times \text{ASA}/100) \text{ CCS}$$

Direct Call Processing (DCP) is the time in seconds that is spent handling incoming ACD calls.

Where the objective of networking is to reduce the number of agents in the Source node while maintaining the same level of service, perform the same calculation but reduce the number of agents at the Source node and calculate trunk traffic without the 50% reduction of ASA in the above formula.

Duration Timer (Overlay 23: DURT)

The Duration Timer indicates how long a Target node honors a call request from the Source node. If the timer expires, the call is removed from the call request queue. The range of the Duration Timer is 15–45 minutes with the default set at 30 minutes. If this timer is too large, the network call request queues may become overcrowded. If the timer is too small, waiting customers may be cut off from receiving services.

This timer must be defined only for Target queues.

Network requirements

The requirements for establishing NACD on a network are outlined in the sections that follow.

Signaling link requirements between Source and Target nodes

If the signaling message for NACD applications is carried by a PRA D-channel between two nodes, the PRA D-channel's signaling capacity is so large that engineering of the link is not required. If the signaling link is ISL, the data rate of the signaling link must be determined. Use care in multiple hops to ensure recalculation of all the traffic on the ISL link. For multiple hops, engineer all links to the same baud rate. Avoid using ISL links at different speeds since this can block messages at the tandem location.

The formula to calculate the ISL/PRA rate is:

$$\text{Number of NACD calls} \times .63 = \text{BPS}$$

where:

BPS = bytes per second

Table 4
Data Link capacity for NACD and ISL calls

Link Data rate (D) in kbps	64	19.2	9.6	4.8	2.4	1.2
NACD Calls	54,064	27,563	15,303	7,655	3,827	1,908
ISL Calls	77,582	39,553	21,960	10,985	5,492	2,738

Overflow traffic estimation

Since removing the high day traffic adjustment is recommended when engineering agent positions, consider 30% of Source traffic as potential overflow traffic. Use this rule when the average agent load at the Source node is unknown. Otherwise, traffic exceeding a loading of 33 CCS per agent is overflowed.

To calculate the number of overflowed calls from the Source node to Target nodes, use the average holding time of 180 seconds.

$$OT0 = A0 - 33 \times N0$$

OT0 = Overflow traffic from Source node in CCS

A0 = ACD traffic in CCS calculated from (Calls Accept $\times$ AVG Work Sec)/100

N0 = number of agents at the Source node

The number of overflow calls = OT0/180

If OT0 is a negative number, the traffic is too low or too many agents are assigned to this location and no calls will overflow onto the network from this node.

Average CCS loading per agent at each ACD DN

The relative ACD DN load between the Source and a Target node is one of the most important considerations in determining where to overflow a waiting call. If the average loading per agent is known, then the node with the lowest average load becomes the highest node in priority to receive overflow calls.

Average Agent Loading in CCS can be calculated from the ACD DN performance report. The equation is as follows:

$$\text{Avg. Agent Loading in CCS} = \text{Average Work/Manned \%} \times 36/100$$

The value of Work/Manned % from a Target ACD DN performance report is the average traffic level of the Target ACD DN during the busy hour of the Source ACD DN.

Call register requirements

The incremental requirements for call registers between ACD and NACD are the additional call registers required at the Source node to hold calls waiting to be overflowed to Target nodes. The recommended procedure is:

X = Calls/hours overflowed to all Target ACD DN's

This is $OT0 \times 100 / HT$

Y = Calls/hours overflowed to the local Target ACD DN's

This is $(OT1 + \dots + OTk) \times 100 / HT$, where k is the number of Target ACD DN's co-located in the Source node.

ASA = Average Speed of Answer in seconds required at the Source node

HT = Average holding time of an NACD call (default is 180 seconds)

Q = Average number of NACD timers expired before the call is answered
(Default is 1.5 queues)

W = Number of calls overflowed from other nodes to the Source node during the busy hour (should be 0 for an efficient network)

t = The first timer value in the NACD table

CRQ = Call Request Queue size

Incremental CR Traffic at Source node

$Snacd = (X + W) \times ASA \times Q / 100 + (X - Y) \times HT / 100 \text{ ccs}$

Incremental CR Traffic at Target node

$Tnacd = CRQ \times (ASA - t) / 100 \text{ ccs}$

Incremental CR traffic at a combined Source and Target node

$Snacd + Tnacd$

Refer to Table 5 to find the number of incremental CRs required for NACD.

Note: Add the incremental CRs to the CR requirement for ACD based on the procedure in the next subsection.

Table 5
Poisson table at P.01 grade of service

CRs	1	2	3	4	5	6	7	9	10	15	20	25	30	35	40
CCS	.4	5.4	15.7	29.6	46	64	84	105	126	269	399	535	675	818	964

This procedure applies when NACD is engineered as an add-on to existing ACD nodes. To completely engineer an ACD network, use the equation in the next section, “CR for new NACD engineering.”

CR for new NACD engineering

Modify the CR engineering equations to include the incremental CR requirement of the NCAD feature. The result of this equation equals the number of CRs required.

$$(T + S_{nacd} + T_{nacd} + 815)/33.8 + M$$

where:

$$T = (A/2 \times C \times 1.42) - M \times L.$$

A = the total voice loop (system) traffic in CCS

$S_{nacd} = 0$, if the system is not an NACD Source node

$T_{nacd} = 0$, if the system is not an NACD Target node

M = the number of ACD incoming trunks

L = average CCS per ACD traffic

C = the call register traffic factor

- = 1 + 0.037 if CDR Charge Account is equipped
- + 0.074 if Authorization Code
- + 0.037 if Parallel CDR ports per customer
- + 0.150 if NARS/BARS/CDP
- + 0.150 if FCBQ and OHQ
- + 0.033 if ACD RAN
- + 0.019 if Teleset Messaging
- + 0.140 if Integrated Messaging System
- + 0.083 if Ring Again
- + 0.033 if Music Trunk
- + 0.067 if Call Park
- + 0.003 if New Flexible Code Restriction
- + 0.039 if ESN Signaling

The accuracy of the above CR equation proves accurate for larger groups, for example, 100 CRs or more. It is not recommended for incremental estimations, which are usually smaller compared with the original ACD CR calculation.

Designing the NACD Routing Table

The objective of designing an overflow Routing Table is to minimize the waiting time of calls in the network without creating excessive internodal traffic.

A point system is used to rank the potential of success if the waiting call at the Source node is put into the Call Request Queue of a Target node. The Target ACD DN with the highest points indicates the best candidate to handle the overflow calls. The point system provides an objective way to evaluate the spare capacity of a potential Target node.

Whenever the same numbers are assigned to multiple ACD DN's due to equal value, the next number will continue, but the total in the set remains the same.

ACD agent group size (P1)

All Target ACD DN's are ranked according to the agent group size. The ACD DN with the largest agent group is assigned P1 = 5, the next one 4, and so on. If there are more than five Target ACD DN's, the rest are assigned zero P1, which means that no more preference is given to agent size after five groups. This variable should not be greater than five in weight. If any two ACD DN's have the same number of agents, they should be assigned the same value. No more than five ACD DN's will be assigned points in this category. In summary:

P1 = 5 for the ACD DN with the largest agent group

P1 = 4 for the next size group

P1 = 3 for the next

P1 = 2 for the next

P1 = 1 for the next

P1 = 0 for the 6th largest or less

Average agent load at each target ACD DN (P2)

Assign the highest priority to the Target node with the lowest average agent load during the Source node busy hour. If any two nodes have the same average DN loading, assign the same points to each of them. The proposed point assignment is as follows:

P2 = 5 for the Target node with the lowest average agent loading per ACD DN

P2 = 4 for the next lowest agent loading per ACD DN

P2 = 3 for the third lowest agent loading per ACD DN

P2 = 2 for the fourth lowest agent loading per ACD DN

P2 = 1 for the fifth lowest agent loading per ACD DN

P2 = 0 for agent loading higher than above

Number of hops (P3)

Multihop routes may require longer message delay, more CPUs to handle the same call, and more tandem trunks, may experience higher blocking, and may cost more because of the charges associated with the distance of the call. Multiple hops require a longer Reserve Agent Timer to wait for the call to set up. Therefore, multihop routes are not encouraged.

The weight of this variable is more than for the other categories listed above.

P3 = 5 if Target is co-located with Source node

P3 = 0 if Target ACD DN is the next node

P3 = -5 if one hop in the route (one tandem connection)

P3 = -7 if two hops in the route

P3 = -9 if three hops in the route

If sufficient trunking is available in an existing tandem route so that blocking and cost penalties are of little concern, the user may change the negative weighting factor assigned to this parameter. One example may be:

P3 = -1 for one hop; P3 = -2 for two hops; P3 = -3 for three hops.

No limitation exists (except for a satellite, which allows only one hop) on the number of hops permitted in an NACD. In a private network, any tandem call requiring more than three hops is unusual.

Noncoincidence busy hour and time zone difference (P4)

P4 is the point allocated to the Target node with a different busy hour from the Source node. Assign four points for each hour's difference in busy hour. For example, if the Source node experiences a busy hour at 9 a.m., and the Target node has a busy hour at 11 a.m., then assign $P4 = 8$ points ($= 4 \times [11-9]$) to the Target node.

This allocation of points is based on the absolute difference of busy hour between the Source and Target node. For example, if the Source node is in Toronto and the Target node is Vancouver, the time zone difference of three hours brings 8 a.m. in Vancouver and 11 a.m. in Toronto into the same real-time hour. Since only an absolute difference in hours is allocated points, no points for nodes are allocated in the example involving Toronto and Vancouver.

If the busy hour of the Source node and a Target node are not known or cannot be located (inconsistency), let $P4 = 0$. In summary:

$P4$ = The points allocated to the Target node with different busy hours from the Source node. Each hour difference is assigned 4 points.

$P4 = 4 \times$ the number of absolute hours difference between the Source and Target node busy hours

$P4 = 0$ if there is no consistent busy hour at the Source and Target nodes

Ranking of Target nodes on NACD Routing Table

Every Target node is assigned points according to its relationship to the Source node based on the above four categories. All points are summed for each node. The node with the highest point total receives the top priority in the routing tables. Nodes are ranked from Q1 to Q20, from the highest to the lowest point total. The Routing Table allows a maximum of 20 DNs.

$$Q = P1 + P2 + P3 + P4$$

Negative values are ranked behind nodes with zero points.

$$Q1 > Q2 > Q3 > \dots Q20$$

If Q_i equals $Q(i + 1)$, choose the node closer to the Source node.

When an NACD has more than five nodes, several nodes after the first five have zero Q_i values. This is expected since they are far down the NACD table. The preference of one node over the other is negligible, because their chances of being offered overflow calls are diminishing.

Timer value in NACD Routing Table

The timer value should allow calls to queue on as many virtual queues as possible, but not congest call request queues. The length of a wait for a call is closely associated with the Average Speed of Answer (ASA) that a customer specifies and which the system is configured to meet. Therefore, the overflow timer (T_i) should be a function of ASA. If the customer does not have an objective ASA, then use the default time interval of 10 seconds.

Recommended settings are as follows:

$T1 = 10$ seconds or ASA/n , whichever is smaller. The value of n is the number of Target DNs.

$T2 = 20$ seconds or $2 \times ASA/n$, whichever is smaller.

$T3 = 30$ seconds or $3 \times ASA/n$, whichever is smaller.

$T4 = 40$ seconds or $4 \times ASA/n$, whichever is smaller.

•

•

$T20 = 200$ seconds or $20 \times ASA/n$, whichever is smaller.

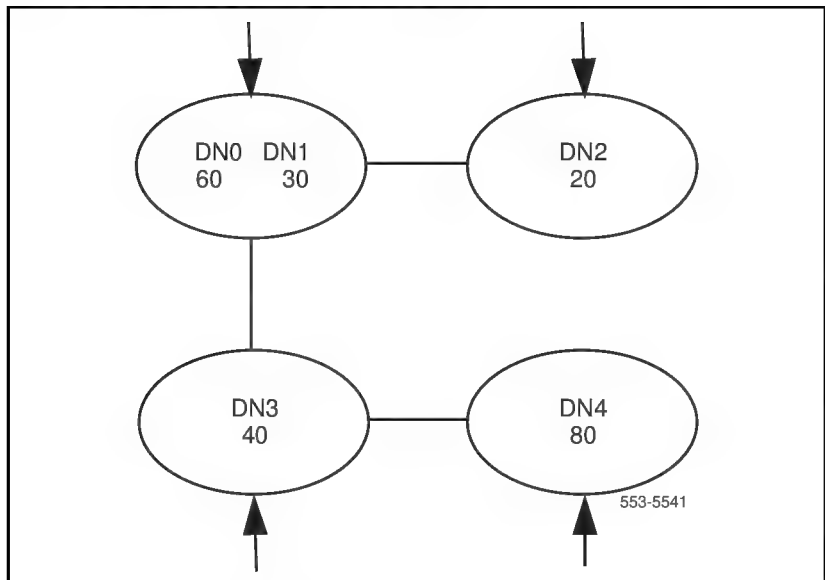
Whenever the timer value calculation results in an odd number, round it to the smaller even number, since the timer interval in NACD operates in 2-second increments. Also, timer values for several DNs can be the same so that when the NACD table contains many entries, a large timer for lower entries may not be necessary.

Engineering example: A 5 ACD DN and 4-Node NACD

The network consists of five ACD DNs and four nodes across three time zones with different busy hours. ACD DN1 is co-located with the Source node ACD DN0. ACD DN3 is a tandem node between the Source node and ACD DN4.

Figure 4 shows a simplified block diagram of the NACD. All DNs denote the ACD DN.

Figure 4
A 5-ACD DN and 4-node NACD network



- 1200 calls Average Busy Season Busy Hour (ABSBH) traffic are offered to the Source node (ACD DN0). The average agent service time, a total of direct call processing and post call processing time, is 180 seconds. The ASA is 60 seconds.
- The number of agents (N_i) is shown under each ACD DN.

- ACD DN0, ACD DN1, and ACD DN2 are within the same time zone.
- ACD DN3 is one hour ahead of ACD DN0.
- ACD DN4 is one hour ahead of ACD DN3 and two hours ahead of ACD DN0.
- CCS per agent was estimated at 33 CCS/agent for ACD DN0, 30 CCS for ACD DN1, 28 CCS for ACD DN2, 25 CCS for ACD DN3, and 25 CCS for ACD DN4 at the busy hour of ACD DN0. The number of agents at ACD DN0 was engineered to handle ABSBH calls. When High Day Busy Hour (HDBH) traffic is offered to ACD DN0, approximately 30% of calls overflow.

Use the following formula to calculate CCS per agent from the ACD report:

- $\text{CCS per agent} = 36 \text{ CCS} \times \text{Total Work} / \text{Total Manned Time}$
- $\text{Work Time} = \text{direct call processing time} + \text{post call processing time}$
- $\text{Manned time} = \text{the time consoles are manned by agents}$

All time units are expressed in total minutes within the busy hour per an ACD DN.

- The busy hour for ACD DN0 is 11 a.m., ACD DN1 is 12 p.m., ACD DN2 is 11 a.m., ACD DN3 is 12 p.m., and ACD DN4 is 1 p.m. All times are expressed relative to the time zone of ACD DN0.

Design of NACD Routing Table The NACD configuration statistics are summarized in the following table. The shaded rows represent points assigned to the parameters above them. The total points for each node are tallied in the last row of Table 6.

Table 6
NACD configuration data and timer priority assignment

Source ACD DN		Target ACD DNs				
Assigned Pts.	Node	DN0	DN1	DN2	DN3	DN4
No. of Agents	NI	60	30	20	40	80
Assigned Points	PI		3	2	4	5
Avg CCS/Agent	ai	33	30	28	25	25
Assigned Points	P2		3	4	5	5
No. of Hops			co-locate	0	0	1
Assigned Points	P3		5	0	0	-5
Bush Hour in DN0 Time		11 a.m.	12 p.m.	11 a.m.	12 p.m.	1 p.m.
Assigned Points	P4		4	0	4	8
Sum of Assigned Points			15	6	13	13

The sum of total points for Target nodes uses the following sequence:

$$Q1 > Q3 = Q4 > Q2$$

Since ACD DN3 is closer to ACD DN0 than ACD DN4, it receives a higher priority than ACD DN4 in the NACD routing table. The sequence of the timer should be ACD DN1 first, ACD DN3 next, ACD DN4 next, and ACD DN2 at the bottom of the list.

The desired ASA for this network is 60 seconds, which yields a timer interval of 14 seconds ($= 60/4-1$). Since it is larger than the default timer value of 10 seconds, use 10 seconds as the timer interval. The NACD routing table looks like this:

Table 7
An NACD Routing Table

Target DN	Time in Seconds
ACD DN1	10
ACD DN3	20
ACD DN4	30
ACD DN2	40

ACD DN1 in this example is a 4-digit directory number, since it is located with the Source ACD DN. The other ACD DNs are likely to have more digits, which are defined according to a Uniform Dialing Plan or a Coordinated Dialing Plan.

Incremental impact engineering

To determine the incremental requirements when the five nodes change from serving individual nodes to NACD, consider the factors discussed in the sections below.

Trunking requirement

Estimate the amount of trunk traffic to be overflowed to other nodes from the source.

Trunk traffic to source ACD DN

$$\text{Trunk CCS} = (1200 \times 1.3 \times 180/100) + (1.3 \times [0.5 \times 60] / 100) = 2808 + 468 = 3276$$

Where the 1200 offered calls to the Source node is the Average Busy Season Busy Hour (ABSBH) traffic, an additional 30% of traffic reflecting High Day Busy Hour (HDBH) peak level is added as recommended in *Meridian 1 capacity engineering* (553-3001-149). If the customer defines the input traffic as an HDBH value, then the 30% adjustment is not required.

The ASA is reduced by half to reflect the effect on queuing time and trunk loading. This incoming traffic (3276 CCS) requires 115 trunks to carry it (based on Poisson P.01).

The incoming trunk requirement is estimated from 3276 CCS. However, for calculating actual overflow traffic, the portion associated with waiting (468 CCS) should be discounted, since it is an overhead in addition to the normal call service time (180 seconds per call), which should not be used for estimating overflow calls.

Overflow traffic from source ACD DN

$$\text{OT0} = 2808 - (33 \times 60) = 828 \text{ CCS or } 460 \text{ calls (with 180 seconds HT)}$$

Where 2808 CCS is the offered traffic to the ACD DN0 agents, the maximum loading per agent is set at 33 CCS or 92%. The CCS is converted to calls by multiplying 100/180 ($= 828 \times 100/180 = 460$).

Calls handled by the Source node agents

$$33 \times 60 \times 100/180 = 1100 \text{ calls handled by ACD DN0.}$$

Agent loading is set at 33 CCS and the average holding time is 180 seconds.

Incremental traffic to each Target node

- 1 The first ACD DN to accept overflow traffic: ACD DN1

The spare capacity at ACD DN1: $S1, 1 = (33 - 30) \times 30 = 90$ CCS

OT1 = the smaller of OT0 (828 CCS) or $S1, 1 = 90$ CCS or 50 calls

Since ACD DN1 is co-located with the Source ACD DN, no trunk is required to handle the overflow traffic.

- 2 The second DN to accept overflow traffic: DN3

The spare capacity at DN3: $S3, 2 = (33 - 25) \times 80 = 640$ CCS

OTC = the smaller of $(828 - 90 - 320)$ or $640 = 418$ CCS

At Poisson P.01 (a customer-designated value; blocking could be higher for a private network), the incremental trunks are 33. This traffic corresponds to 410 ($= 178 + 232$) overflowed calls.

- 3 The third DN to accept overflow traffic: DN4

The spare capacity at DN4: $S4, 3 = (33 - 25) \times 80 = 640$ CCS

OT3 = the smaller of $(828 - 90 - 320)$ or $640 = 418$ CCS

At Poisson P.01 (a customer-designated value; blocking could be higher for a private network), the incremental number of trunks required to handle 418 CCS is 21. The number of calls on this route is 232.

The traffic between the Source node and node 3 is 738 ($= 320 + 418$) CCS. The required incremental trunks are 33. This traffic corresponds to 410 ($= 178 + 232$) overflowed calls.

- 4 The fourth DN to accept overflow traffic: DN2

ACD – DN4: $232 \times 0.63 = 147$ bps. This is the data rate for the link between ACD DNs and ACD DN4.

Real-time requirement

Incremental real time is the extra processing time required of the Source node CPU to handle NACD overflow calls to all Target nodes. The Target node CPU does not require special engineering, since it is not in its busy hour and handles calls only when it has spare capacity.

Calls to all target ACD DN

Incremental real time of NACD overflow calls: $460 \times 1.38 = 635$ EBC.

where:

460 is the total number of overflow calls from the Source ACD DN.

Incremental real time of NACD/ACD calls handled at the Source node over the basic incoming trunk to SL-1 set calls = 1100×0.60 EBC, where 1100 is the total number of calls handled by the Source ACD DN agents. This EBC should be taken care of if the NACD configuration is evolved from an existing ACD node. If the Source ACD DN is a new NACD node converted from a non-ACD switch, then the real-time impact is 1295 EBC (= 635 + 660).

When a Target node becomes a Source node during its busy hour, the rest of the nodes in the network are treated as Target nodes. When two or more nodes are Source nodes in the same busy hour, design the NACD routes tables one at a time and treat the rest of the nodes as Target nodes.

Call register requirement

From the “Overflow traffic from source ACD DN” on page 110 and “Incremental traffic to each Target node” on page 111, calls from ACD DN0 and to ACD DN1 can be calculated:

$X = 460$ calls (total overflow calls from ACD DN0)

$Y = 50$ calls (calls overflowed to ACD DN1)

Incremental Source node CR traffic: $Snacd = (460 \times 30 \times 1.5/100) + (460 - 50) \times (180/100) = 945$ CCS, where an ASA of 30 seconds is assumed. Referring to a Poisson table with P.01 Grade of Service, the additional number of CRs required for the NACD application is 40.

Since none of the Target ACD DNs accepting overflow traffic has the same busy hour as the Source node, assume that all Tnacd traffic (CR traffic for each Target ACD DN) can be absorbed by the spare CRs available due to non-busy-hour traffic overflowing to that Target ACD DN.

Note: Although the number of calls offered to the NACD is 1200, the network is engineered for 1560 calls due to the ABSBH versus HDBH considerations.

